Demographics, Purchasing Behaviors, and Nutrient Composition among Vending Machine Consumers at The Ohio State University

Thesis

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ABSTRACT

The United States has seen a rapid increase in the rate of obesity over the last three decades and snacking may have contributed to this epidemic. The frequency and prevalence of snacking, the numbers of snacks consumed per day, and the energy density of snack foods have all increased in recent years. Vending machines are common avenues for distributing snack foods. Little is known about consumers who purchase snack food items from vending machines, particularly on college campuses. The objectives of this study were to: 1) Determine if vending consumers who select green, yellow, or red items differ significantly in their demographic (gender, age, building location) and purchasing behaviors (frequency, motivation); 2) Determine if differences exist between average consumed nutrients from vended food products (calories, vitamin A, vitamin C, dietary fiber, calcium, potassium, protein, fat, saturated fat, trans fat, sugar, sodium) for green, yellow, and red consumers. A cross-sectional survey of vending consumers at 18 preselected campus vending machines was completed, and subsequent statistical analyses were performed to determine the differences among consumers. The type of building and age of the consumer were associated with the type of item (green, yellow, red) selected. Green items were selected significantly more ($p<0.001$) at the Recreation and Physical Activity Center (RPAC) than at classroom buildings, the medical center, office buildings, and residence halls. For all ages, (18-24, 25-34, 35-44, 45-54, and 55+), red items were chosen significantly more often than green or yellow items ($p <0.015$). Also, significant differences were found among the average nutrients consumed by green, yellow, and red consumers. Those consuming red items consumed significantly more calories, fat, saturated fat, and sugar ($p <0.0001$), than those consuming green items. Those consuming green items consumed significantly more

vitamin A, vitamin C, dietary fiber, calcium, potassium, and protein ($p < 0.0001$), than those consuming red items. Data such as this can be useful in determining target groups for strategies aimed at decreasing the quantity and improving the quality of snack food choices of vending consumers.

CHAPTER 1

Introduction

The United States has seen a rapid increase in the rate of obesity among its citizens over the last few decades. Nearly 34% of American adults[1] and 17% of American children and adolescents are categorized as obese[2]. While many factors have contributed to this epidemic, one potential contributor is the proportion of nutrients consumed outside of the home[3]. For many Americans who spend a significant portion of their day away from home, snacking has become a common avenue for nutrient intake.

Snacking in America has changed over the past three decades. The frequency and prevalence of snacking have increased[4], the number of snacks consumed per day has increased[5], and the energy density of snack foods has increased[6]. These trends suggest that snacking may be a potential contributor to obesity.

Vending machines provide ready access to cheap snack food items. College campuses typically offer many vending machine choices, and provide readily available options for snacking.

At The Ohio State University, a Healthy Snack Program has been adopted to guide vending machine options. A nutrient rating system developed by Columbus' Nationwide Children's Hospital is used to evaluate the nutrient density of vending machine foods. The foods, based on their nutrient density score, are assigned one of three colors: "green" for those items to be chosen most often; "yellow" for those items to be chosen only occasionally; and "red" for those items which should be chosen most seldom. As guided by the Healthy Snack Program, the contract with the snack food vendor specifies that vending machines supply of

28.5% green, 43% yellow, and 28.5% red items[9]. The intent of this Healthy Snack Program is that vending machine consumers at The Ohio State University will choose healthier items when purchasing from vending machines, and will do so more frequently. Simply put, the goal of Snackwise® is to help patrons of vending machines make better choices.

The objectives of this study were to: 1) Determine if vending consumers who select green, yellow, or red items differ significantly in their demographic (gender, age, building location) and purchasing behaviors (frequency, motivation); 2) Determine if differences exist between average consumed nutrients from vended food products (calories, vitamin A, vitamin C, dietary fiber, calcium, potassium, protein, fat, saturated fat, trans fat, sugar, sodium) for green, yellow, and red consumers.

Accordingly, research aims and hypotheses were:

1. Determine if vending consumers who select green, yellow, or red snack food items differ significantly in their demographic (gender, age, building location) and purchasing behaviors (frequency, motivation).
    - H_0: There will be no significant difference in consumers who purchase green, yellow, and red snack food items.
    - H_1: There will be a significant difference in consumers who purchase green, yellow, and red snack food items.
2. Determine if there is a significant difference between the nutrients consumed (calories, vitamin A, vitamin C, dietary fiber, calcium, potassium, protein, fat, saturated fat, trans fat, sugar, sodium) for green, yellow, and red consumers.
    - H_0: There will be no significant difference in the nutrients consumed between consumers who purchase green, yellow, and red snack items.

- H_1: There will be a significant difference in the nutrients consumed between consumers who purchase green, yellow, and red snack items.

CHAPTER 2

Literature Review

Roughly one-third (33.8%) of American adults are obese, which corresponds to a body mass index (BMI) of over 30[1]. This problem is not a new one; obesity in America has been growing at an alarming rate for decades. In 2000, there was not a single state with an obesity prevalence of over 30%. However, by 2009, nine states were over 30%; in 2010, there were twelve states with such numbers[1]. Perhaps even more troublesome is the increase in obesity in children. About 17% of children and adolescents are now obese; this number has almost *tripled* since 1980[2].

While numerous factors have contributed to these obesity trends such as total kilocalorie consumption per day and consuming larger portion sizes, increases in the number of meals consumed away from the home may be contributing to this epidemic. From 1971 to 2006, the percentage of food consumed outside of the home increased from 24-40%[3]. Snacking is a common way to eat outside the home, and may have become a significant potential contributor to weight gain. Not only has the frequency of snacking significantly increased, but its prevalence has increased in all age groups[4]. From 1977-1996, the number of snacks people consumed per day increased by 14%[5]; from 2003-2006, the prevalence of snacking among US adults increased from 71-97%[6]. An issue with this substantial increase in snacking is that snacking is positively related to energy intake, regardless of physical activity[3]. Additionally, the energy density of snack foods has increased over time, and the contribution of snack food to the daily total energy intake increased from 18-24% from 1977-2006[5]. Indeed, research has shown that increased

snacking may be associated with a greater risk of energy imbalance, as well as pose as an increasing threat to becoming overweight or obese[5].

Of the various options individuals possess to snack during the day when out of their home, purchasing snack foods from vending machines is deemed a very inexpensive and often times convenient choice. Sparse data exists in the literature regarding vending machine purchases from a nutritional point of view. A recent study that examined the frequency of vending machine purchases found that individuals who purchase with a higher frequency had a lower self-efficacy towards obtaining a healthier snack, and that they purchased more frequently due to the vending machines' convenience and availability[7]. When examining vending machine purchases on a college campus, a recent study at a mid-Atlantic university discovered that 43% of their college freshman claimed to have increased their machine purchases since commencing college[8]. Considering the lack of data available on vending machine patron's purchasing behaviors, demographics, and average nutrients consumed, this study aims to gather such information with hopes of gaining additional insight about vending machine consumers.

At The Ohio State University, a Healthy Snacking Program was implemented in 2009 using the Snackwise® rating system. Snackwise®, developed by Nationwide Children's Hospital, uses 11 parameters from the nutrition facts label to calculate nutrient density. These scores are then used to place the snack foods into three categories. Items designated "green" are those snack foods that should be chosen most often; items designated "yellow" should be chosen occasionally; and items designated "red" should be chosen least often. In accordance with contractual obligations, there must be very specific proportions of green, yellow, and red items available in the vending machines on The Ohio State University campus: 28.5% green, 43% yellow, and 28.5%

CHAPTER 3

Methodology

Research Design

The design for this pilot study was a cross-sectional survey of vending consumers at eighteen pre-selected campus vending machines. Vending consumers were observed and interviewed by trained interviewers (n=47). The protocol was approved as Exempt by the Institutional Review Board (IRB) for social and behavioral human subject research on 2/18/2011, and all interviewers completed Collaborative Institutional Training Initiative (CITI) training.

Vending Machine Selection

The convenience sample of eighteen vending machines was drawn from a selection of the highest grossing vending machines in five types of buildings on campus: classroom buildings, medical center, office buildings, residential halls, and the RPAC. Machines from each building category were selected. Four different vending machines were chosen for observation at the following building types:

- Residence Halls: Baker East, Baker West, Park Hall, Patterson Hall
- Office Buildings: Biomedical Research Towers, Enarson Hall, Hamilton Hall, Meiling Hall
- Medical Center: James Cancer Hospital, Ross Heart Hospital, Cramblett Hall, Rhodes Hall
- Classroom Buildings: Baker Systems Engineering, Evans Lab, Schoenbaum Hall, University Hall

Two vending machines were chosen for observation at the RPAC.

Instrumentation

Vending purchases were observed, and observable data was collected: gender, building type, item chosen. A quick intercept survey was administered to patrons who gave informed consent, and data collected included: frequency of purchase, motivation for purchase, age, and university affiliation. (see Appendix A for data collection sheet).

Methods

The methodology was based off a previous study conducted in the spring of 2010[9]. Data was collected during two collection periods over a three-week period. During each data collection period, machines were observed by the trained interviewers on Tuesday and Wednesday for 12 hours, 7am-7pm, each day. Table 1 outlines the buildings chosen and dates that each machine was observed.

Table 1: Buildings Observed and Dates of Observation

Building Name	**Type of Building**	**Dates Observed**
Baker East	Residence Hall	3/8/2011-3/9/2011
Baker West	Residence Hall	3/1/2011-3/2/2011
Park Hall	Residence Hall	3/1/2011-3/2/2011
Patterson Hall	Residence Hall	3/8/2011-3/9/2011
Biomedical Research Towers	Office Building	2/22/2011-2/23/2011
Enarson Hall	Office Building	2/22/2011-2/23/2011
Hamilton Hall	Office Building	3/1/2011-3/2/2011
Meiling Hall	Office Building	3/1/2011-3/2/2011
James Cancer Hospital	Medical Center	3/1/2011-3/2/2011
Ross Heart Hospital	Medical Center	2/22/2011-2/23/2011
Cramblett Hall	Medical Center	2/22/2011-2/23/2011
Rhodes Hall	Medical Center	2/22/2011, 3/1/2011-3/2/2011
Baker Systems Engineering	Classroom Building	2/22/2011-2/23/2011
Evans Lab	Classroom Building	2/22/2011-2/23/2011
Schoenbaum Hall	Classroom Building	3/1/2011-3/2/2011
University Hall	Classroom Building	3/1/2011-3/2/2011
RPAC	RPAC	2/22-2/23,3/1-3/2,3/8-3/9/2011

Internal Validity

This research is a pilot investigation and is not designed to be generalized to the campus population. The vending machines that were observed were conveniently selected to create the most variation in the population of vending consumers. The results from the study are not intended to be a valid representation of campus vending consumers, but are designed to gain insight for further research.

Data Analysis

Chi-squared analyses tests were performed to determine differences among demographics and purchasing behaviors with color chosen. Log-linear models with 3-way tables were also utilized to compare color chosen with two other demographic and behavioral variables. Finally, analysis of variance testing using Tukey LS means was executed to compare nutrient levels by color.

CHAPTER 4

Results

Sample

A total of 970 vending machine purchases were observed. Of these, 652 patrons participated in the survey (67.2% participation rate); 561 were females (57.8%) and 409 were males (42.2%). Vending consumers represented persons of all age ranges, with consumers age 18-24 representing 56.2% of purchases (see Table 2). In terms of which building types yielded the most purchases, classroom buildings accounted for the highest with 42.2%, followed by the medical center buildings with 25.3% (see Table 3).

Table 2: Purchases by Age Range

	Green	Red	Yellow
18-24 (n=356; 56.2%)	73 20.5%	186 52.2%	97 27.2%
25-34 (n=94; 14.8%)	14 14.9%	65 69.1%	15 16.0%
35-44 (n=62; 10.0%)	9 14.5%	37 59.7%	16 25.8%
45-54 (n=56; 8.8%)	8 14.3%	33 58.9%	15 26.8%
55+ (n=55; 8.7%)	7 12.7%	39 70.9%	9 16.4%
Unknown (n=10; 1.5%)	2 20.0%	2 20.0%	6 60.0%

Table 3: Purchases by Building Type

	Green	Red	Yellow
Classroom (n=396; 42.2%)	64	249	83
	16.2%	62.9%	21.0%
Medical Center (n=238; 25.3%)	26	160	52
	10.9%	67.2%	21.8%
Office (n=134; 14.3%)	16	81	37
	11.9%	60.4%	27.6%
Residence Halls (n=113; 12.0%)	19	68	26
	16.8%	60.2%	23.0%
RPAC (n=58; 6.2%)	20	16	22
	34.5%	27.6%	37.9%

Hypothesis 1

Significant differences among consumers' demographic variables and product color were found based on their age range and building type. Patrons from all age ranges selected significantly higher proportions of red items versus green and yellow items, $\chi^2_{10}= 22.121$, $p<0.015$ (Table 2). Although not significantly different, for consumers in the age range of 55+, 70.9% of items chosen were red, while only 16.4% were yellow and 12.7% green. Red items were chosen significantly less at the RPAC than the other building types, $\chi^2_8= 37.946$, $p<0.001$ (Table 3). In fact, red items were chosen with less frequency than both green and yellow items at the RPAC.

Significant differences were not found between item color selected and gender, university affiliation, frequency of purchase, or reasons for purchase.

Hypothesis 2

Significant differences were found among the average nutrients consumed by consumers who selected green, yellow, and red snack food items (Table 4). Those consuming red items consumed significantly more calories, fat, saturated fat, sodium, and sugar than those consuming green items; those consuming green items consumed significantly more vitamin A, vitamin C, dietary fiber, calcium, potassium, and protein than those consuming red items, $p<0.0001$. The average consumed nutrients of yellow consumers were interesting. Those consuming yellow items consumed significantly less vitamin C, dietary fiber, calcium, protein, calories, vitamin A, potassium, sugar, and saturated fat than green consumers; significantly less fat, calories, vitamin A, sugar, and saturated fat than red consumers; significantly more sodium than green consumers; and significantly more potassium and sodium than red consumers, $p<0.0001$.

Table 4: Nutrient Composition by Color

	Green	**Yellow**	**Red**	
Vit. C (% based off 2000 kcal diet)	22.6	0.5	0.5	*
Dietary Fiber (g)	3.0	1.3	1.3	*
Calcium (% based off 2000 kcal diet)	20.3	2.2	3.0	*
Protein (g)	3.9	3.6	3.4	*
Fat (g)	4.3	4.5	10.6	*
Calories (kcal)	161.5	138.6	264.2	*
Vit. A (% based off 2000 kcal diet)	14.2	0.9	3.5	*
Potassium (mg)	39.6	21.6	0.0	*
Sugar (g)	13.7	4.8	21.6	*
Sodium (mg)	135.5	205.3	180.2	*
Saturated Fat (g)	1.4	0.6	3.6	*
Trans Fat (g)	0.0	0.0	0.0	

*$p < 0.0001$

= significant grouping

CHAPTER 5

Discussion

Various results were obtained from this study. Patrons from all age ranges selected significantly higher proportions of red items versus green and yellow items, as well as purchasing red items more often than green and yellow items at all building types, except at the RPAC. However, significant differences were not found between item color selected and gender, university affiliation, frequency of purchase, or reasons for purchase. Interesting results arose from the average consumed nutrients of vending consumers, as those consuming red items consumed significantly more calories, fat, saturated fat, sodium, and sugar than those consuming green items; those consuming green items consumed significantly more vitamin A, vitamin C, dietary fiber, calcium, potassium, and protein than those consuming red items.

While the literature on this topic is sparse, the results obtained here are similar to previous studies. There were no significant reasons consumers had as to their motivation for purchase; common answers given consisted of their purchase being a meal replacement, or that they didn't have time to go home or to a restaurant. This is consistent with the literature that people are indeed consuming nutrients away from their homes. Additionally, previous research has suggested that the prevalence of snacking has increased in all age groups; this is troublesome as this study found that red items are being consumed significantly more than green or yellow items in all age ranges.

It is necessary to discuss that the sample collected in this study does not reflect the vending population on The Ohio State University's campus as a whole. This was not a purely random sample; it was a convenience sample. The buildings chosen were the highest grossing

vending machines, which is convenient to use because it would hypothetically provide the largest sample but not necessarily a representative one. The 7a.m.-7p.m. timeframe was convenient for the interviewers, as it would have been challenging to recruit volunteers for night shifts. Therefore, the results obtained cannot be generalized to the entire vending population on Ohio State's campus. Future research should aim to be a randomized study of vending consumers across campus.

There were various limitations in this study, one of which has already been mentioned. The 7a.m.-7p.m. timeframe may have omitted a significant percentage of vending consumers, as a potentially large consumer base from 7p.m.-7a.m. was unstudied; evening and night hours may represent a busy time for vending machine purchases. Future research should include a full 24 hours of observation to ensure that every vending machine purchase is recorded. Each location was observed for only two consecutive days; this may not be reflective of consumers' purchasing behaviors on an everyday basis. Observing each location for 24 hours one day a week for a year should provide a more representative depiction of consumers' behaviors at that specific vending machine. An additional limitation was that the observations were made during winter quarter, and therefore are only representative of purchasing behaviors for that time of year. Future research should be repeated year round, as consumers' purchasing behaviors might differ depending on the current season.

The results obtained from this study are concerning. According to the Dietary Guidelines 2010, the American population needs to increase potassium, dietary fiber, calcium, and vitamin D; decrease sodium, fats, and sugar; and control total calorie intake in order to avoid potential health concerns[10]. While red items only represented 28.5% of available items, they were purchased with the highest frequency across all ages. This is a cause for concern because red

items are high in the nutrients that the population needs to decrease, low in the nutrients that need to be increased, and high in calories when compared to green items.

While it is very possible that snacking may contribute to obesity, in reality there is little evidence to suggest that snacking itself is a significant cause of obesity and/or other health related issues[10]. The problem to focus on is more of *what* food items are being consumed as snacks. As was shown in this study, there is a significant difference in nutrients consumed based on the quality of snack that's purchased. While we cannot say snacking contributes definitively to obesity, it is clearly evident that *how* one snacks can affect that quality of nutrient intake. If this "quality of intake" is consistent over time, this can affect health and nutritional status, which may lead to obesity and other health concerns in the future. Future research should investigate if how individuals snack is consistent over time, and if snacking habits are similar to how that individual eats in general. This can lead to future research of tracking the similarities/differences among individuals' snacking trends and general eating habits; if an individual not only snacks on poor quality foods, but also tends to eat poor quality foods for their meals, then this may correlate to a high rate of obesity and obesity related conditions.

The nutrient composition of red items along with the literature suggesting that snack foods consumed per day have increased dramatically over the last 35 years[6], the energy density of snack foods increasing[5], and individuals purchasing from vending machines due to convenience and availability[8], is troubling. New strategies implemented to improve the snack food environment may help impact the obesity epidemic. The results obtained here are a beneficial first step in determining what vending machine consumers at The Ohio State University purchase. However, in order for these findings to help initiate legislation or change consumer purchasing habits in the future, much more research needs to be completed. This

study adds to the sparse amount of research available about vending machine consumers' purchasing behaviors, especially on a major college campus.

APPENDIX A

Data Collection Sheet

Purchase Demographics

Time of Purchase: _____

Vending Machine Location _____

Observable Data
(Circle One / Write In)

1. Gender: Male Female

2. Item Purchased: _____

Will Consumer Participate in Questionnaire? Yes No

If Yes:

Intercept Survey
(Write In Answers of Respondents)

1a. What is your affiliation to the University? (Circle one)

a. Student b. Staff c. Faculty d. Other (write in)

1b. If Staff:
e. Medical Staff f. Non-medical Staff

2. How frequently do you make vending machine purchases? (Check one)

___ a. More than 3 times/week ___ b. 1 – 3 times/week

___ c. 2 times/month ___ d. 1 time/month

___ e. Less than 1 time/month ___ f. Unknown

3. Why do you purchase foods from a vending machine? (write in)

_____.

4. How old are you? (circle one)

a. 18-24 b. 25-35 c. 35-45 d. 45-55 e. 55+ f. Unknown

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